

### 600 V Reverse Conducting Drive 2 offering cost effective IGBT with monolithically integrated diode

#### Features

- $V_{CE} = 600\text{ V}$
- $I_C = 4\text{ A}$
- Very tight parameter distribution
- Operating range of 1 to 20 kHz
- Maximum junction temperature  $150^\circ\text{C}$
- Short circuit capability of  $3\ \mu\text{s}$
- Humidity robust design
- Pb-free lead plating; RoHS compliant
- Complete product spectrum and PSpice Models: <http://www.infineon.com/rc-d2>

#### Potential applications

- Ceiling fan
- Countertop appliances - mixing
- Kitchen hood
- Refrigerators
- Residential aircon indoor unit
- Washing machines
- General purpose drives (GPD)

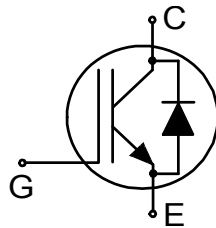
#### Product validation

- Qualified for industrial applications according to the relevant tests of JEDEC47/20/22

#### Description



- Green
- Halogen-free
- RoHS



Type	Package	Marking
IKN04N60RC2	PG-SOT223-3	K4DRC2

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## 1 Package

**Table 1** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Storage temperature	$T_{stg}$		-55		150	°C
Soldering temperature	$T_{sold}$	wave soldering / reflow soldering (MSL1 according to JEDEC J-STA-020)			260	°C
Thermal resistance, min. footprint junction-ambient	$R_{th(j-a)}$				160	K/W
Thermal resistance, 6 cm <sup>2</sup> Cu on PCB junction to ambient	$R_{th(j-a)}$				75	K/W
IGBT thermal resistance, junction-case <sup>1)</sup>	$R_{th(j-c)}$				18.4	K/W
Diode thermal resistance, junction-case <sup>1)</sup>	$R_{th(j-c)}$				26.3	K/W

1)  $R_{th}/Z_{th}$  based on single cooling pulse. Please be aware that a correct  $R_{th}$  measurement of the IGBT, is not possible using a thermocouple.

## 2 IGBT

**Table 2** Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit	
Collector-emitter voltage	$V_{CE}$	$T_{vj} \geq 25\text{ °C}$	600	V	
DC collector current, limited by $T_{vjmax}$ <sup>1)</sup>	$I_C$		$T_c = 25\text{ °C}$	7.5	A
			$T_c = 100\text{ °C}$	4.1	
Pulsed collector current, $t_p$ limited by $T_{vjmax}$	$I_{Cpulse}$		12	A	
Turn-off safe operating area		$V_{CE} \leq 600\text{ V}$ , $t_p = 1\text{ }\mu\text{s}$ , $T_{vj} \leq 150\text{ °C}$	12	A	
Gate-emitter voltage	$V_{GE}$		$\pm 20$	V	
Transient gate-emitter voltage	$V_{GE}$	$t_p \leq 10\text{ }\mu\text{s}$ , $D < 0.01$	$\pm 30$	V	
Short-circuit withstand time	$t_{SC}$	$V_{CC} \leq 400\text{ V}$ , $V_{GE} = 15\text{ V}$ , Allowed number of short circuits < 1000, Time between short circuits $\geq 1.0\text{ s}$ , $T_{vj} = 150\text{ °C}$	3	$\mu\text{s}$	
Power dissipation	$P_{tot}$		$T_c = 25\text{ °C}$	6.8	W
			$T_c = 100\text{ °C}$	2.7	

1) DPAK equivalent

**Table 3** Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Collector-emitter saturation voltage	$V_{CEsat}$	$I_C = 4\text{ A}, V_{GE} = 15\text{ V}$	$T_{vj} = 25\text{ °C}$		2	2.3	V
			$T_{vj} = 150\text{ °C}$		2.3		
Gate-emitter threshold voltage	$V_{GETh}$	$I_C = 45\text{ }\mu\text{A}, V_{CE} = V_{GE}$		4.3	5	5.7	V
Zero gate-voltage collector current	$I_{CES}$	$V_{CE} = 600\text{ V}, V_{GE} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$			25	$\mu\text{A}$
			$T_{vj} = 150\text{ °C}$			2500	
Gate-emitter leakage current	$I_{GES}$	$V_{CE} = 0\text{ V}, V_{GE} = 20\text{ V}$				100	nA
Transconductance	$g_{fs}$	$I_C = 4\text{ A}, V_{CE} = 20\text{ V}$			2		S
Input capacitance	$C_{ies}$	$V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}, f = 1000\text{ kHz}$			180		pF
Output capacitance	$C_{oes}$	$V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}, f = 1000\text{ kHz}$			10		pF
Reverse transfer capacitance	$C_{res}$	$V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}, f = 1000\text{ kHz}$			7		pF
Gate charge	$Q_G$	$I_C = 4\text{ A}, V_{CC} = 480\text{ V}, V_{GE} = 15\text{ V}$			24		nC
Turn-on delay time	$t_{d(on)}$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_{Gon} = 49\text{ }\Omega, R_{Goff} = 49\text{ }\Omega, L_\sigma = 30\text{ nH}, C_\sigma = 32\text{ pF}$	$T_{vj} = 25\text{ °C}, I_C = 4\text{ A}$		8		ns
			$T_{vj} = 150\text{ °C}, I_C = 4\text{ A}$		8		
Rise time (inductive load)	$t_r$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_{Gon} = 49\text{ }\Omega, R_{Goff} = 49\text{ }\Omega, L_\sigma = 30\text{ nH}, C_\sigma = 32\text{ pF}$	$T_{vj} = 25\text{ °C}, I_C = 4\text{ A}$		10		ns
			$T_{vj} = 150\text{ °C}, I_C = 4\text{ A}$		10		
Turn-off delay time	$t_{d(off)}$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_{Gon} = 49\text{ }\Omega, R_{Goff} = 49\text{ }\Omega, L_\sigma = 30\text{ nH}, C_\sigma = 32\text{ pF}$	$T_{vj} = 25\text{ °C}, I_C = 4\text{ A}$		126		ns
			$T_{vj} = 150\text{ °C}, I_C = 4\text{ A}$		137		
Fall time (inductive load)	$t_f$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_{Gon} = 49\text{ }\Omega, R_{Goff} = 49\text{ }\Omega, L_\sigma = 30\text{ nH}, C_\sigma = 32\text{ pF}$	$T_{vj} = 25\text{ °C}, I_C = 4\text{ A}$		24		ns
			$T_{vj} = 150\text{ °C}, I_C = 4\text{ A}$		26		
Turn-on energy	$E_{on}$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_{Gon} = 49\text{ }\Omega, R_{Goff} = 49\text{ }\Omega, L_\sigma = 30\text{ nH}, C_\sigma = 32\text{ pF}$	$T_{vj} = 25\text{ °C}, I_C = 4\text{ A}$		95		$\mu\text{J}$
			$T_{vj} = 150\text{ °C}, I_C = 4\text{ A}$		127		
Turn-off energy	$E_{off}$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_{Gon} = 49\text{ }\Omega, R_{Goff} = 49\text{ }\Omega, L_\sigma = 30\text{ nH}, C_\sigma = 32\text{ pF}$	$T_{vj} = 25\text{ °C}, I_C = 4\text{ A}$		62		$\mu\text{J}$
			$T_{vj} = 150\text{ °C}, I_C = 4\text{ A}$		82		
Total switching energy	$E_{ts}$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_{Gon} = 49\text{ }\Omega, R_{Goff} = 49\text{ }\Omega, L_\sigma = 30\text{ nH}, C_\sigma = 32\text{ pF}$	$T_{vj} = 25\text{ °C}, I_C = 4\text{ A}$		157		$\mu\text{J}$
			$T_{vj} = 150\text{ °C}, I_C = 4\text{ A}$		209		

(table continues...)

**Table 3 (continued) Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Operating junction temperature	$T_{vj}$		-40		150	°C

Note: Electrical Characteristic, at  $T_{vj} = 25^{\circ}\text{C}$ , unless otherwise specified

### 3 Diode

**Table 4 Maximum rated values**

Parameter	Symbol	Note or test condition	Values	Unit	
Repetitive peak reverse voltage	$V_{RRM}$	$T_{vj} \geq 25^{\circ}\text{C}$	600	V	
Diode forward current, limited by $T_{vjmax}$ <sup>1)</sup>	$I_F$		$T_c = 25^{\circ}\text{C}$	4.9	A
			$T_c = 100^{\circ}\text{C}$	2.3	
Diode pulsed current, $t_p$ limited by $T_{vjmax}$	$I_{Fpulse}$		12	A	

1) DPAK equivalent

**Table 5 Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Diode forward voltage	$V_F$	$I_F = 4\text{ A}$	$T_{vj} = 25^{\circ}\text{C}$	1.85	2.2	V
			$T_{vj} = 150^{\circ}\text{C}$	1.9		
Diode reverse recovery time	$t_{rr}$	$V_R = 400\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$ , $I_F = 4\text{ A}$ , $-di_F/dt = 483\text{ A}/\mu\text{s}$	39		ns
			$T_{vj} = 150^{\circ}\text{C}$ , $I_F = 4\text{ A}$ , $-di_F/dt = 500\text{ A}/\mu\text{s}$	100		
Diode reverse recovery charge	$Q_{rr}$	$V_R = 400\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$ , $I_F = 4\text{ A}$ , $-di_F/dt = 483\text{ A}/\mu\text{s}$	0.097		$\mu\text{C}$
			$T_{vj} = 150^{\circ}\text{C}$ , $I_F = 4\text{ A}$ , $-di_F/dt = 500\text{ A}/\mu\text{s}$	0.259		
Diode peak reverse recovery current	$I_{rrm}$	$V_R = 400\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$ , $I_F = 4\text{ A}$ , $-di_F/dt = 483\text{ A}/\mu\text{s}$	4.7		A
			$T_{vj} = 150^{\circ}\text{C}$ , $I_F = 4\text{ A}$ , $-di_F/dt = 500\text{ A}/\mu\text{s}$	5.8		

(table continues...)

**Table 5** (continued) **Characteristic values**

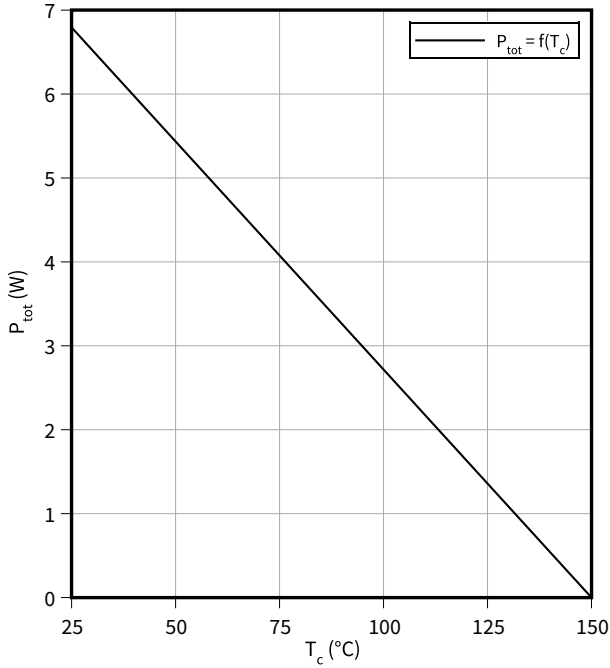
Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode peak rate of fall of reverse recovery current	$di_{rr}/dt$	$V_R = 400 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}, I_F = 4 \text{ A},$ $-di_F/dt = 483 \text{ A}/\mu\text{s}$		174		A/ $\mu\text{s}$
			$T_{vj} = 150 \text{ }^\circ\text{C},$ $I_F = 4 \text{ A},$ $-di_F/dt = 500 \text{ A}/\mu\text{s}$		67.4		
Operating junction temperature	$T_{vj}$			-40		150	$^\circ\text{C}$

*Note: For optimum lifetime and reliability, Infineon recommends operating conditions that do not exceed 80% of the maximum ratings stated in this datasheet.*

## 4 Characteristics diagrams

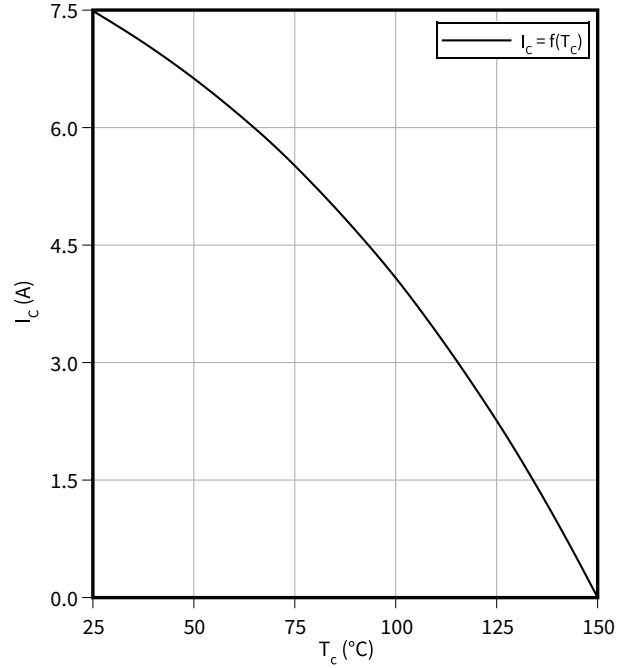
### Power dissipation as a function of heatsink temperature

$P_{\text{tot}} = f(T_c)$   
 $T_{\text{vj}} \leq 150\text{ }^\circ\text{C}$



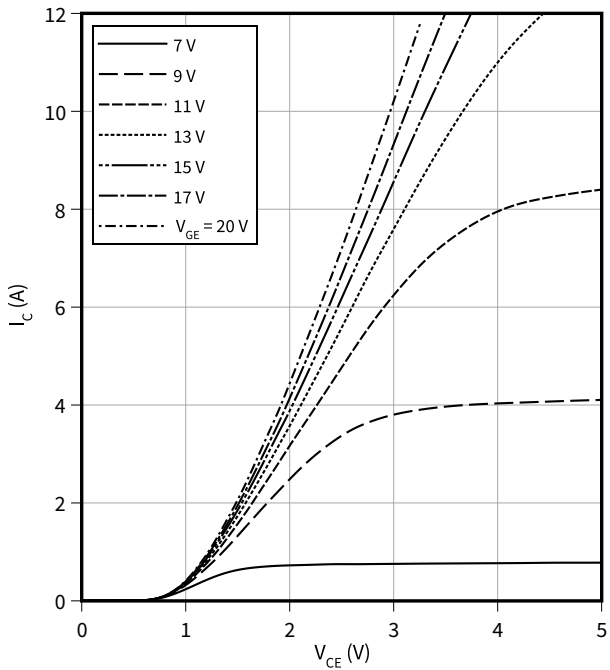
### Collector current as a function of heatsink temperature

$I_c = f(T_c)$   
 $T_{\text{vj}} \leq 150\text{ }^\circ\text{C}, V_{\text{GE}} \geq 15\text{ V}$



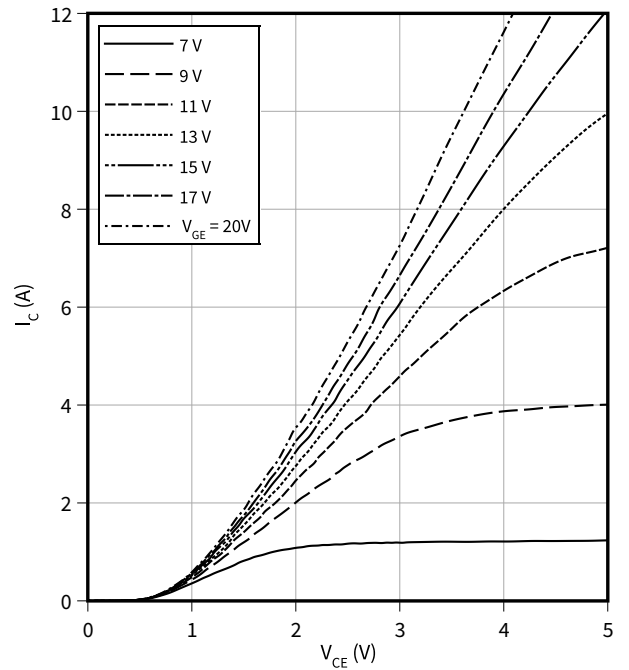
### Typical output characteristic

$I_c = f(V_{\text{CE}})$   
 $T_{\text{vj}} = 25\text{ }^\circ\text{C}$



### Typical output characteristic

$I_c = f(V_{\text{CE}})$   
 $T_{\text{vj}} = 150\text{ }^\circ\text{C}$

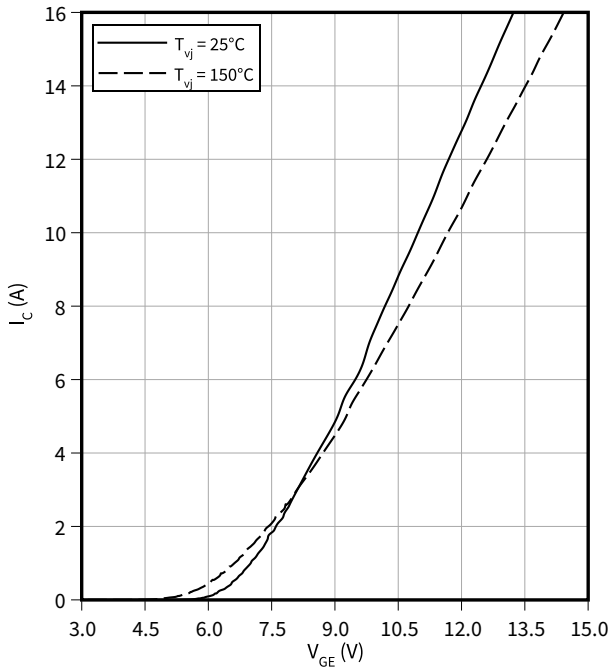


4 Characteristics diagrams

**Typical transfer characteristic**

$I_C = f(V_{GE})$

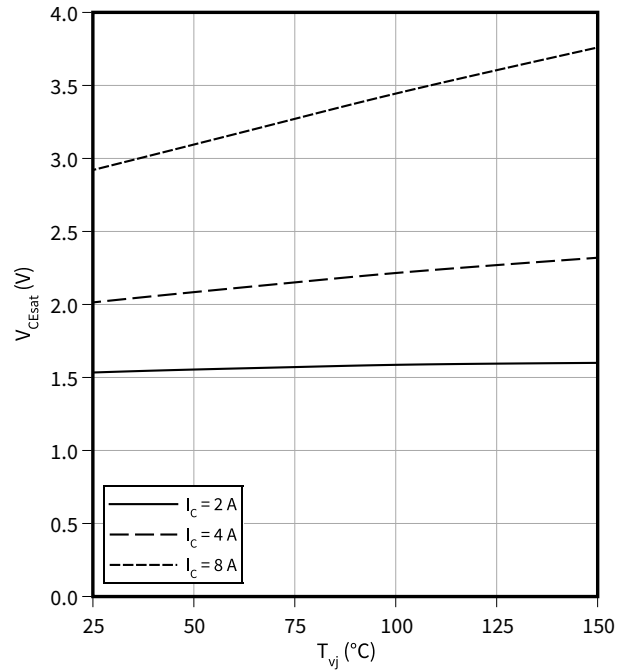
$V_{CE} = 20 \text{ V}$



**Typical collector-emitter saturation voltage as a function of junction temperature**

$V_{CEsat} = f(T_{vj})$

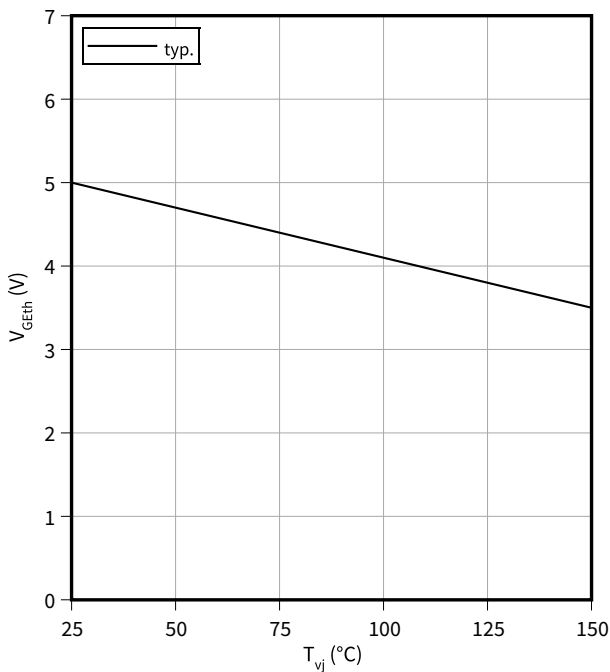
$V_{GE} = 15 \text{ V}$



**Gate-emitter threshold voltage as a function of junction temperature**

$V_{GEth} = f(T_{vj})$

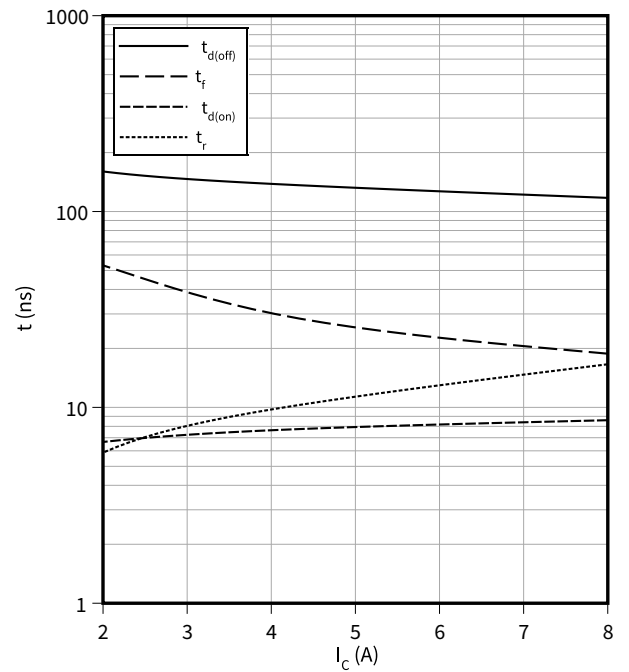
$I_C = 45 \mu\text{A}$



**Typical switching times as a function of collector current**

$t = f(I_C)$

$V_{CC} = 400 \text{ V}, T_{vj} = 150^\circ\text{C}, V_{GE} = 0/15 \text{ V}, R_G = 49 \Omega$



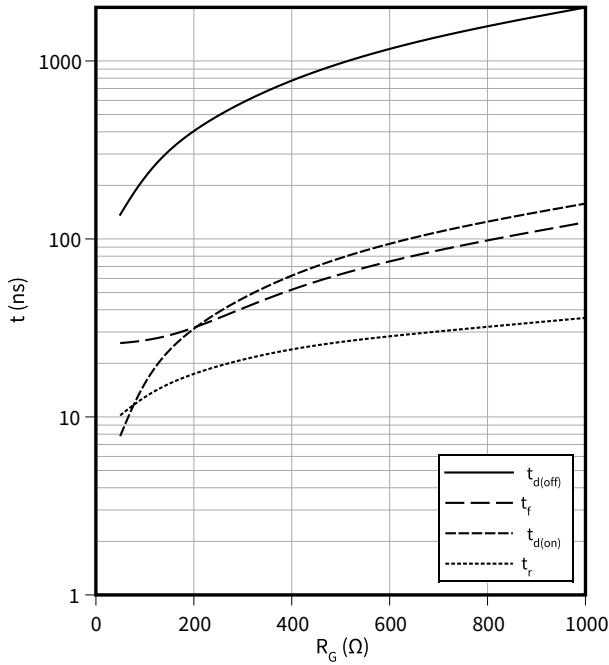


4 Characteristics diagrams

**Typical switching times as a function of gate resistor**

$t = f(R_G)$

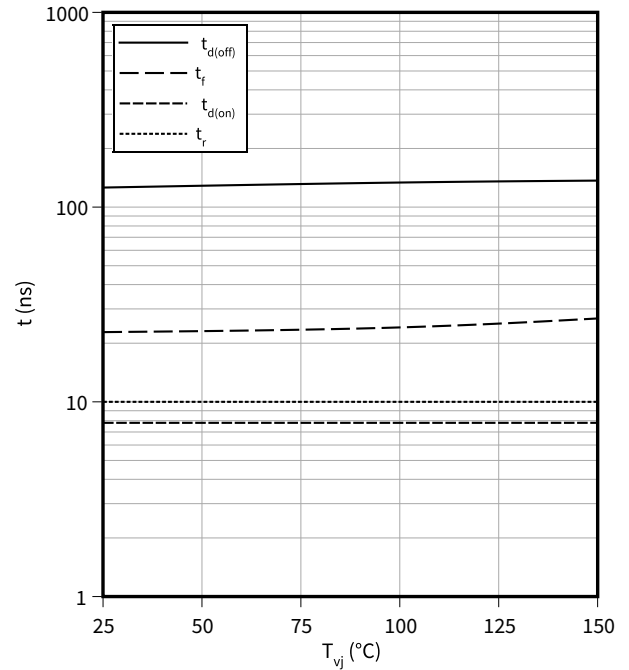
$I_C = 4 \text{ A}, V_{CC} = 400 \text{ V}, T_{vj} = 150 \text{ }^\circ\text{C}, V_{GE} = 0/15 \text{ V}$



**Typical switching times as a function of junction temperature**

$t = f(T_{vj})$

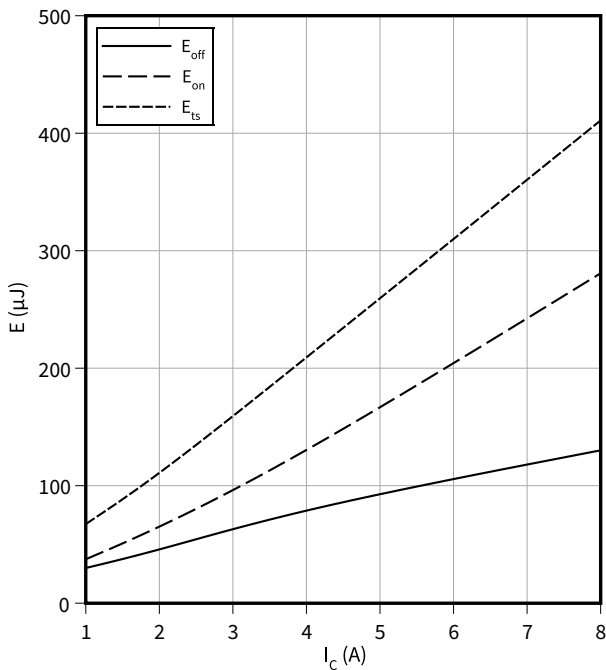
$I_C = 4 \text{ A}, V_{CC} = 400 \text{ V}, V_{GE} = 0/15 \text{ V}, R_G = 49 \text{ } \Omega$



**Typical switching energy losses as a function of collector current**

$E = f(I_C)$

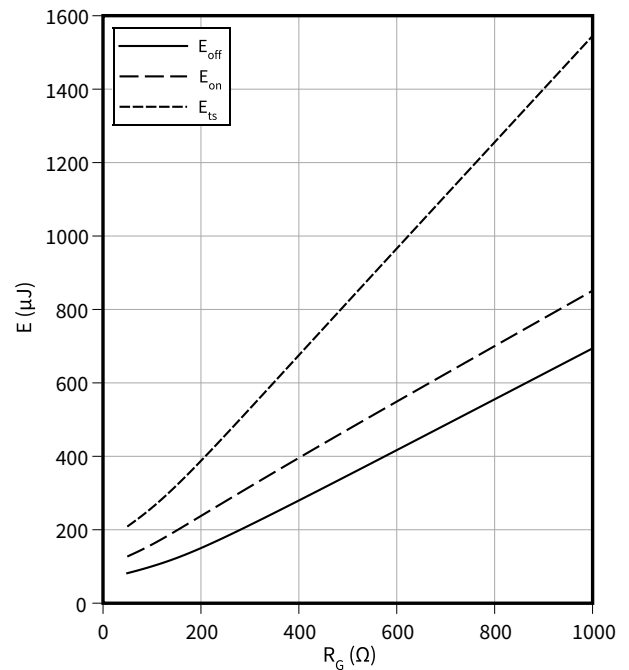
$V_{CC} = 400 \text{ V}, T_{vj} = 150 \text{ }^\circ\text{C}, V_{GE} = 0/15 \text{ V}, R_G = 49 \text{ } \Omega$



**Typical switching energy losses as a function of gate resistor**

$E = f(R_G)$

$I_C = 4 \text{ A}, V_{CC} = 400 \text{ V}, T_{vj} = 150 \text{ }^\circ\text{C}, V_{GE} = 0/15 \text{ V}$

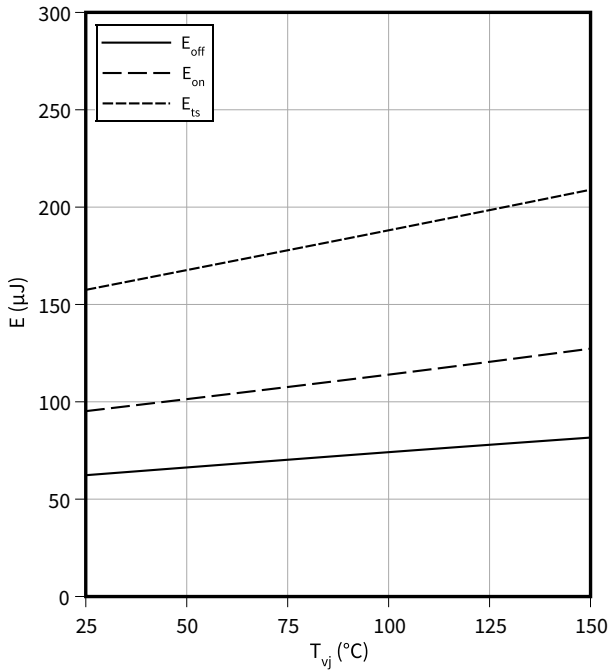


4 Characteristics diagrams

**Typical switching energy losses as a function of junction temperature**

$E = f(T_{vj})$

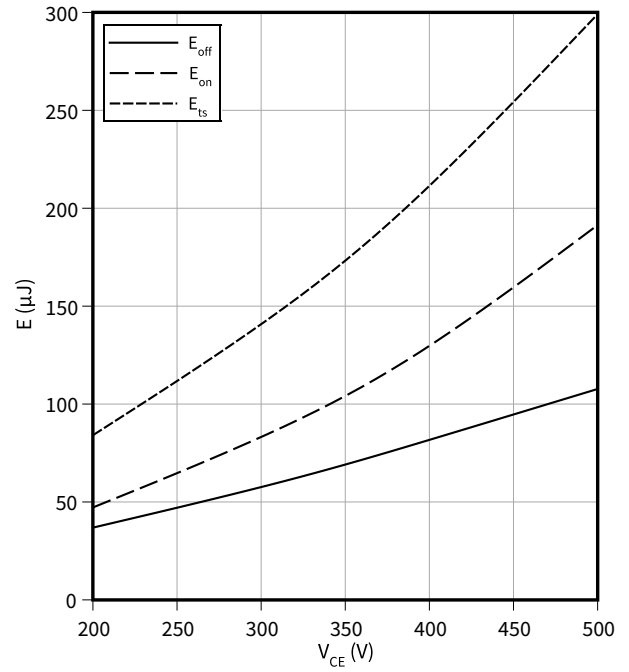
$I_C = 4 \text{ A}$ ,  $V_{CC} = 400 \text{ V}$ ,  $V_{GE} = 0/15 \text{ V}$ ,  $R_G = 49 \Omega$



**Typical switching energy losses as a function of collector emitter voltage**

$E = f(V_{CE})$

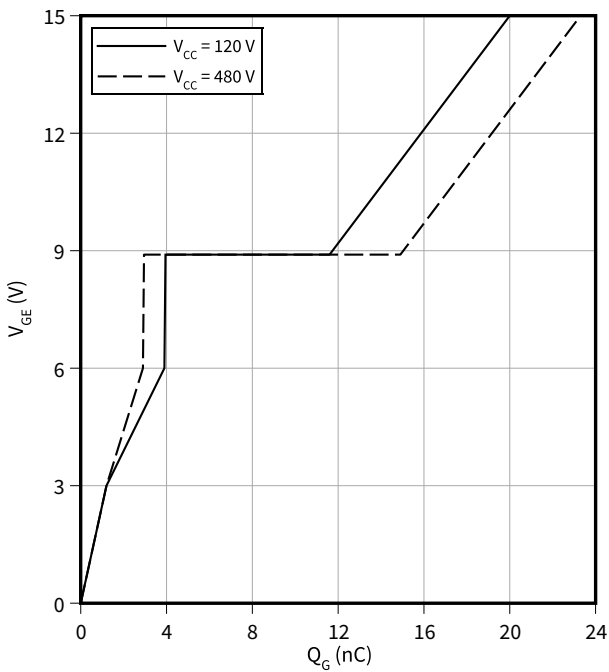
$I_C = 4 \text{ A}$ ,  $T_{vj} = 150 \text{ °C}$ ,  $V_{GE} = 0/15 \text{ V}$ ,  $R_G = 49 \Omega$



**Typical gate charge**

$V_{GE} = f(Q_G)$

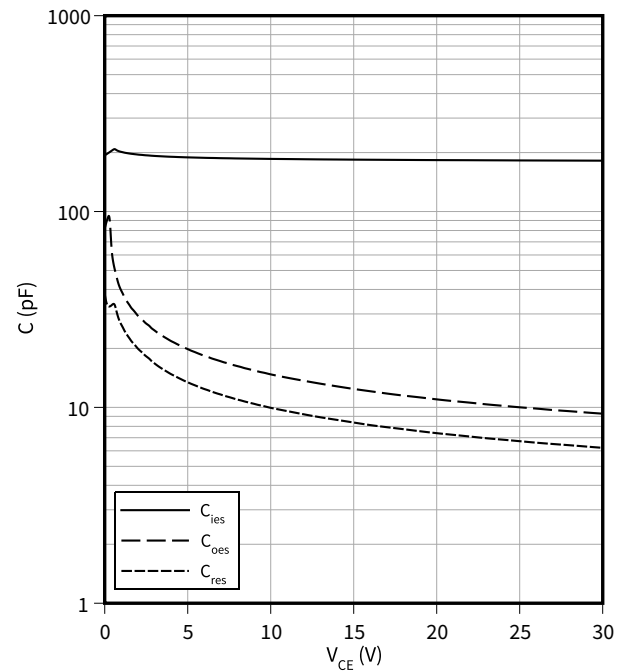
$I_C = 4 \text{ A}$



**Typical capacitance as a function of collector-emitter voltage**

$C = f(V_{CE})$

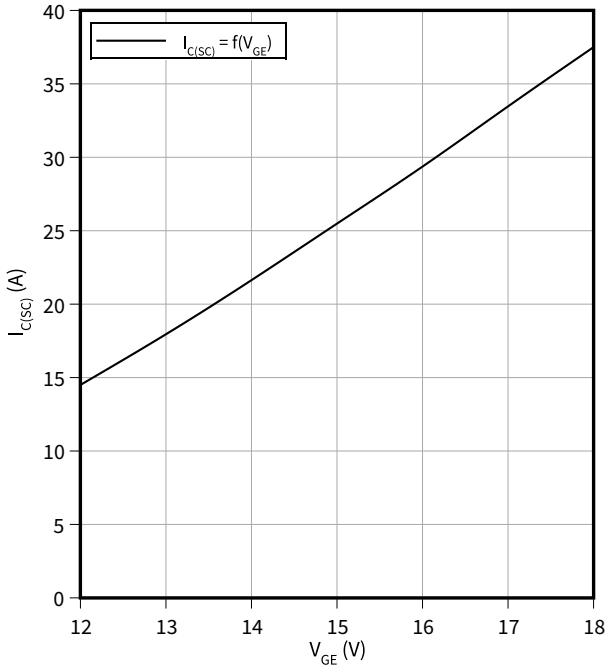
$f = 1000 \text{ kHz}$ ,  $V_{GE} = 0 \text{ V}$



4 Characteristics diagrams

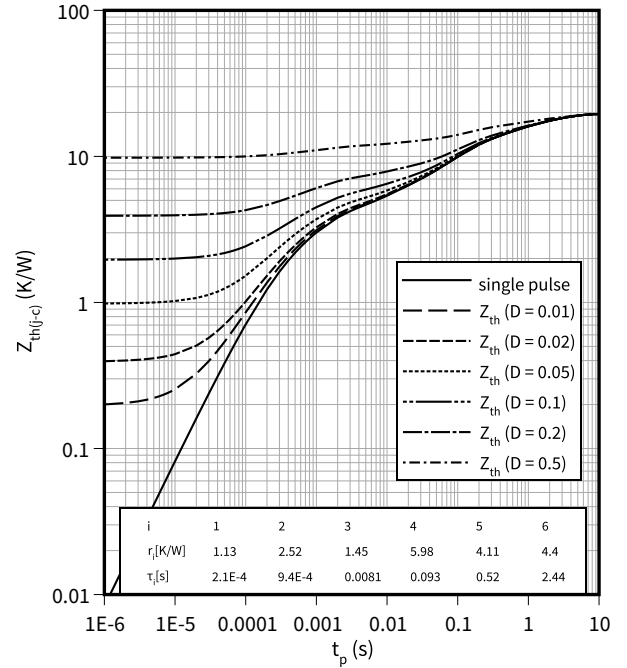
**Typical short circuit collector current as a function of gate-emitter voltage**

$I_{C(SC)} = f(V_{GE})$   
 $T_{vj} \leq 150\text{ }^{\circ}\text{C}, V_{CC} \leq 400\text{ V}$



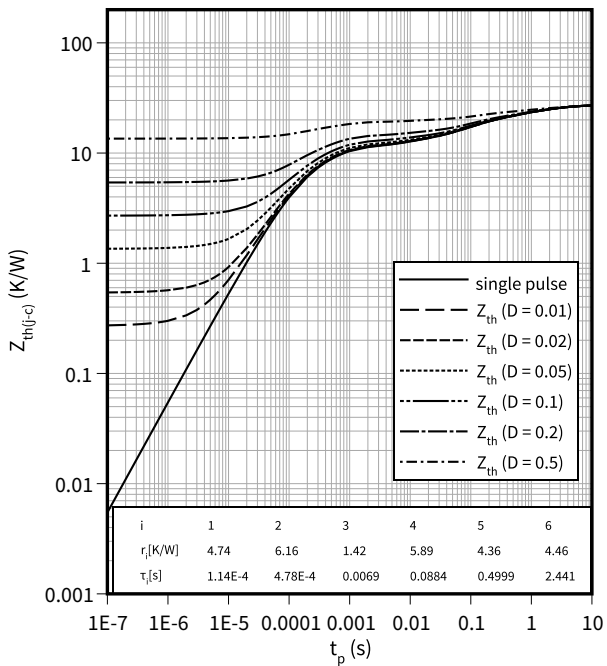
**IGBT transient thermal impedance as a function of pulse width**

$Z_{th(j-c)} = f(t_p)$   
 $D = t_p/T$



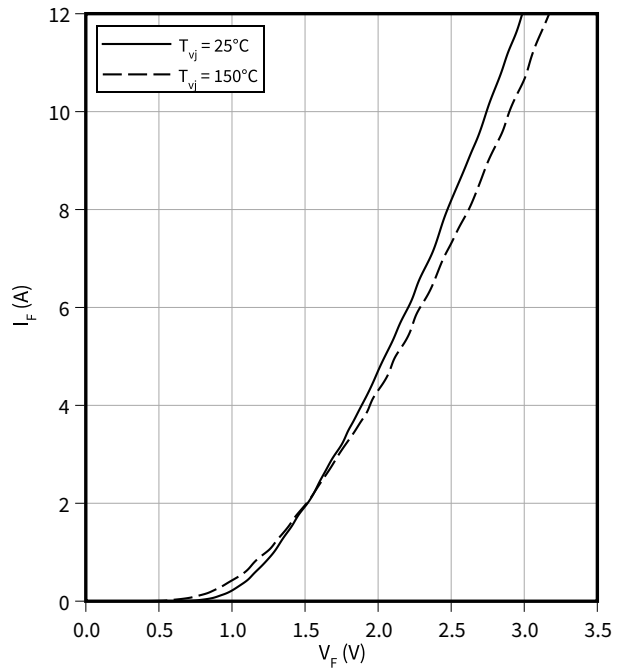
**Diode transient thermal impedance as a function of pulse width**

$Z_{th(j-c)} = f(t_p)$   
 $D = t_p/T$



**Typical diode forward current as a function of forward voltage**

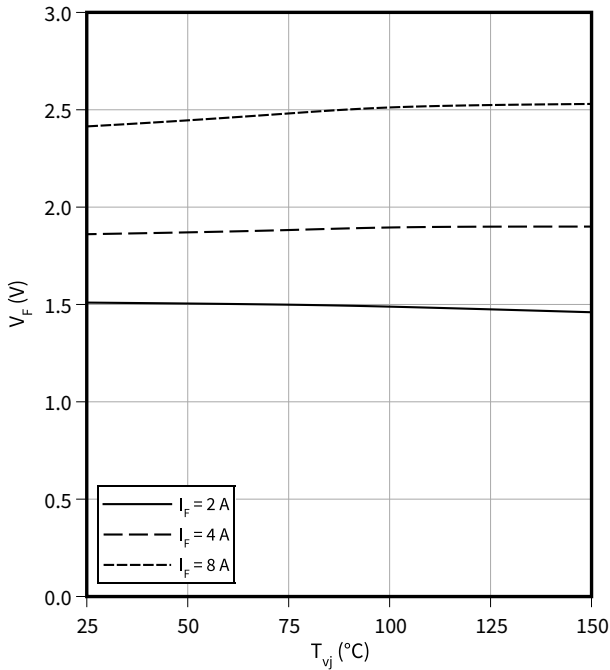
$I_F = f(V_F)$



4 Characteristics diagrams

**Typical diode forward voltage as a function of junction temperature**

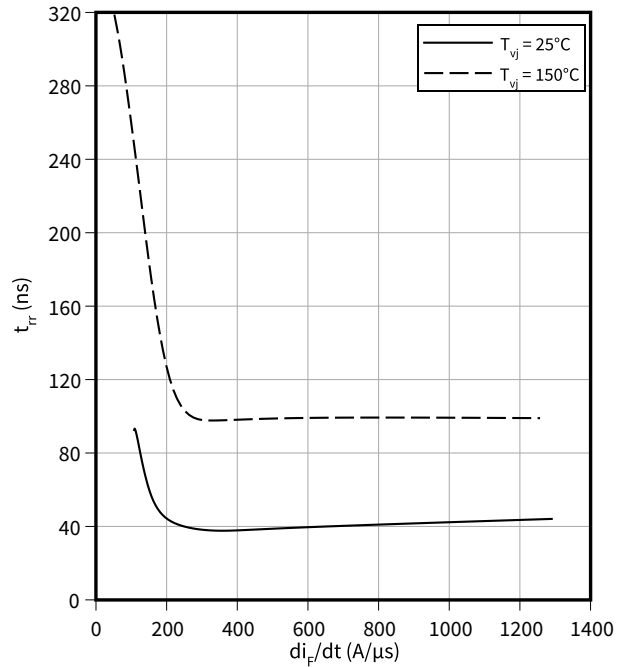
$V_F = f(T_{vj})$



**Typical reverse recovery time as a function of diode current slope**

$t_{rr} = f(di_F/dt)$

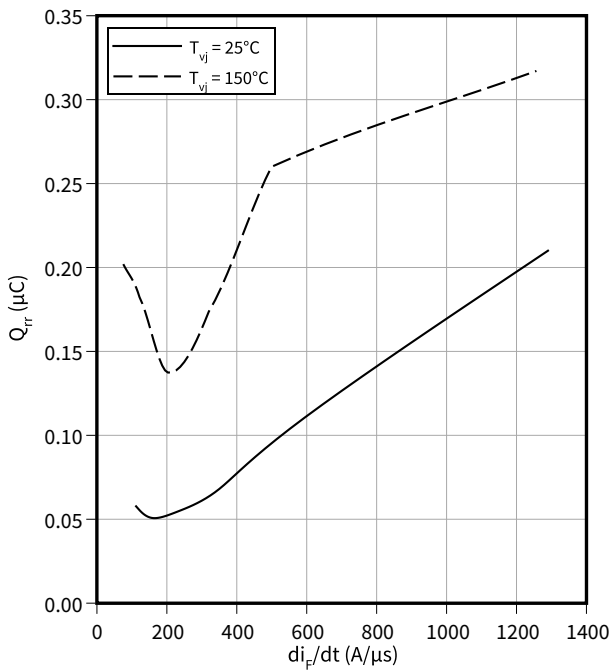
$V_R = 400$  V,  $I_F = 4$  A



**Typical reverse recovery charge as a function of diode current slope**

$Q_{rr} = f(di_F/dt)$

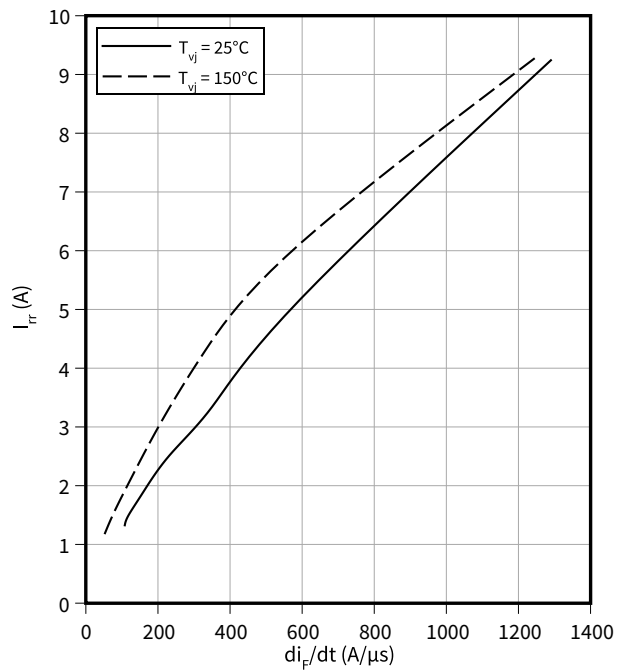
$V_R = 400$  V,  $I_F = 4$  A



**Typical reverse recovery current as a function of diode current slope**

$I_{rr} = f(di_F/dt)$

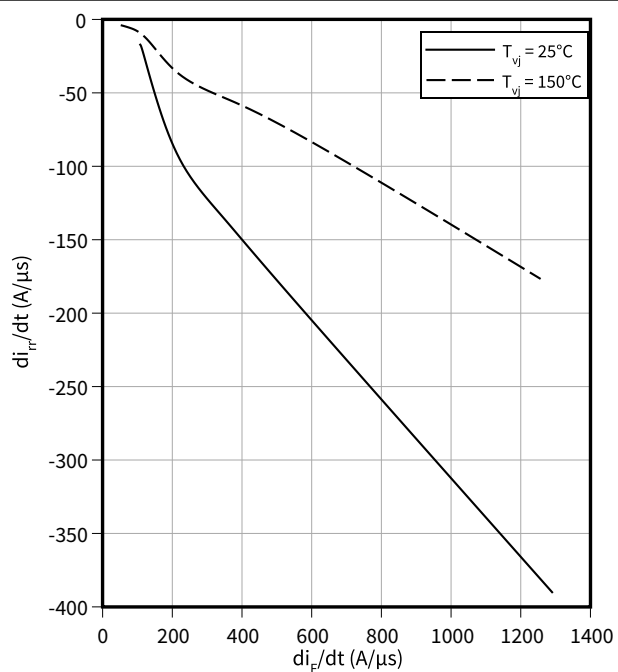
$V_R = 400$  V,  $I_F = 4$  A



**Typical diode peak rate of fall of reverse recovery current as a function of diode current slope**

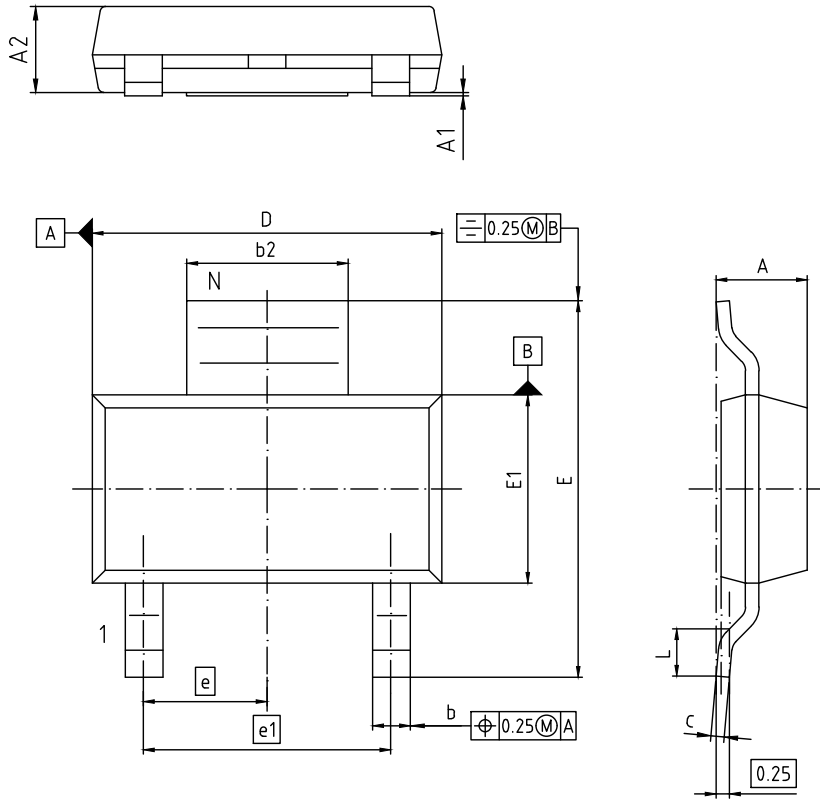
$$di_{rr}/dt = f(di_F/dt)$$

$V_R = 400 \text{ V}$ ,  $I_F = 4 \text{ A}$



**5 Package outlines**

**PG-SOT223-3**



NOTES:  
 1. ALL DIMENSIONS REFER TO JEDEC STANDARD TO-261

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	1.52	1.80	0.060	0.071
A1	-	0.10	-	0.004
A2	1.50	1.70	0.059	0.067
b	0.60	0.80	0.024	0.031
b2	2.95	3.10	0.116	0.122
c	0.24	0.32	0.009	0.013
D	6.30	6.70	0.248	0.264
E	6.70	7.30	0.264	0.287
E1	3.30	3.70	0.130	0.146
e	2.3 BASIC		0.091 BASIC	
e1	4.6 BASIC		0.181 BASIC	
L	0.75	1.10	0.030	0.043
N	3		3	
O	0°	10°	0°	10°

**DOCUMENT NO.**  
Z8B00180553

**SCALE**

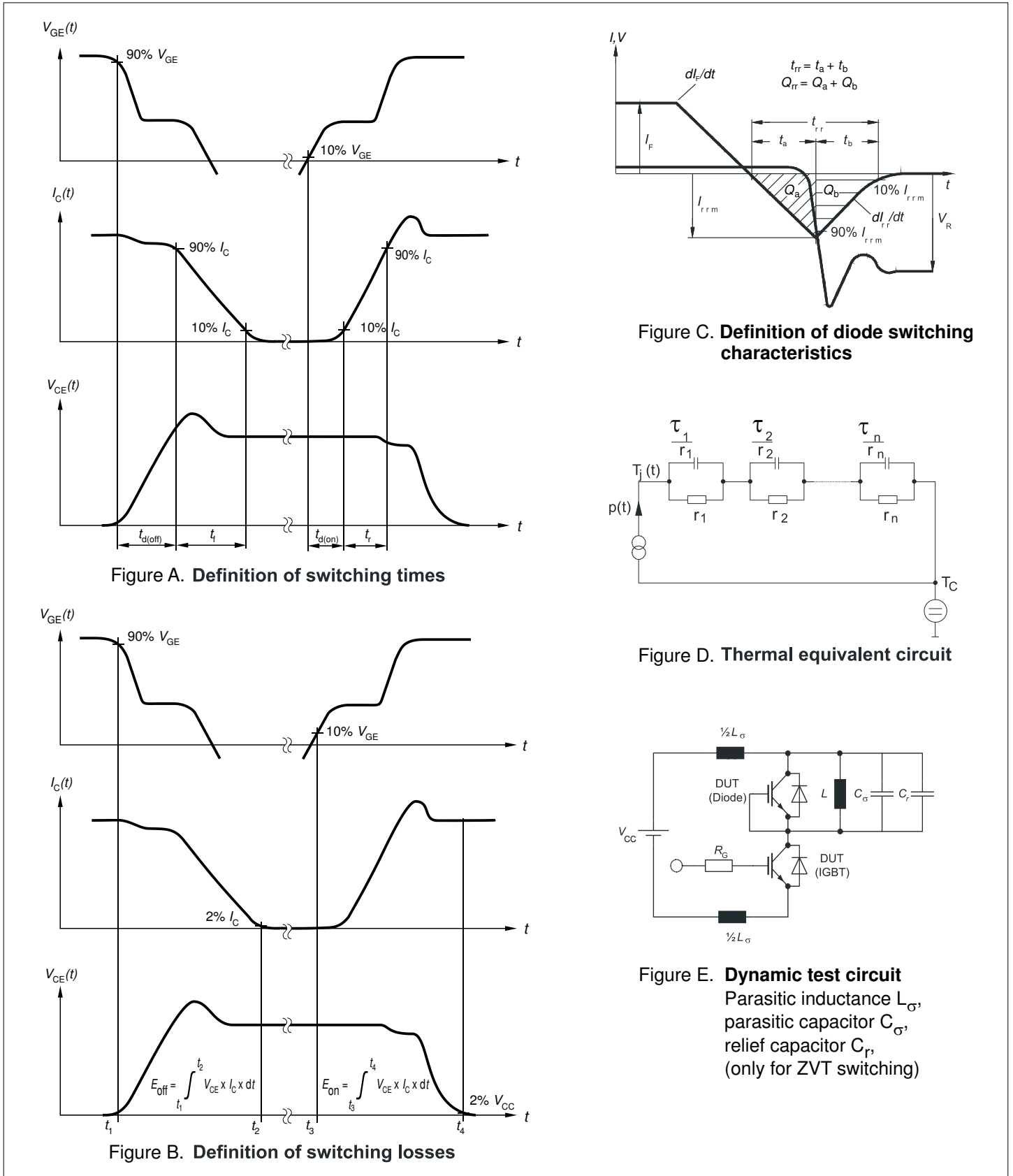
**EUROPEAN PROJECTION**

**ISSUE DATE**  
24-02-2016

**REVISION**  
01

**Figure 1**

**6 Testing conditions**



**Figure 2**

## Revision history

Document revision	Date of release	Description of changes
1.00	2021-09-28	Final datasheet
1.01	2021-10-15	Change of Potential Applications
1.10	2022-09-21	Add of wave soldering conditions



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**Edition 2022-09-21**

**Published by**

**Infineon Technologies AG**

**81726 Munich, Germany**

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**Document reference**

**IFX-ABB482-003**

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